

A RACONTEUR'S TALE

Arvind Gupta

More than thirty years ago, when few schools cared about children understanding concepts and not just learning by rote, Arvind Gupta threw up a job as an engineer to make toys from trash—so that he could teach children to love science.

Arvind Gupta has got a truckload of new playthings. A friend sent him 600 CDs and plastic bottles, the detritus of an IT seminar, and he's spent the past week snipping, bending and glueing, doing what he does best—turning trash into toys.

He holds up a 200-ml Bisleri bottle with shiny discs implanted in its sides and a long metal rod skewering it. 'This is a great way to demonstrate the concept of a wind turbine,' he says as the contraption catches the fan's breeze and spins merrily, the sliced-up CDs reflecting light, rainbow colours bouncing off the floor of the large room stacked with books,

toys, bits and bobs of all kinds. Every surface is covered with a toy or the promise of one.

An electrical engineer who started his career at Tata Motors, Arvind has spent the last thirty-five-odd years as a toy inventor. He makes science fun by doing experiments in schools and getting children to create their own toys to understand basic scientific principles. Reading and storytelling are his other passions so he writes books and translates hundreds of others into Hindi so that anyone can read stories such as Richard Bach's *Jonathan Livingston Seagull*, Art Spiegelman's *Maus*, and Isaac Asimov's *How We Found Out* series on scientific breakthroughs. 'Growing up, I didn't have access to many books. I don't want anyone else to be limited by that. Stories move people more than anything,' says Arvind, who heads the Children's Science Centre at the Inter-University Centre for Astronomy and Astrophysics (IUCAA) in Pune.

In a campus full of serious space scientists using laws of physics and chemistry to question the beginnings of the universe and understand our place in it, Arvind the inventor is a quirky and gentle soul who has spent his life teaching the basics of science and sharing his love for the subject so that children may one day debate bigger scientific questions. He describes himself as a Gandhian at heart, wears a kurta over trousers that flap an inch above his ankles, and derives simple joy from his own inventions and achievements that he hopes will spark the imagination of someone somewhere. He's a rambling raconteur who digresses easily into monologues on education, tales of nineteenth-century trade unionists, and anecdotes about famous friends.

His gravelly voice and precise diction seem to lend conviction to the way he speaks, and though he moves fairly

slowly and deliberately, there's a sense of suppressed energy about him. He drops a thin black-and-yellow book on the table. *The Story of Solar Energy* is an illustrated biography of the sun, which Arvind wrote after the Fukushima nuclear disaster following the March 2011 tsunami in Japan. 'I was so angry and depressed by it. Then I felt I should channel that energy into something positive. So I wrote this. I thought people should know about how different cultures used the sun's energy in the past and how we can now,' he says.

Though he is best known as a toy inventor and is a popular science teacher, there is no limit to Arvind's curiosity. His website www.arvindguptatoys.com has more e-books than you can count, in English, Hindi, Marathi and other languages, on topics ranging from science, philosophy and education to architecture and astronomy, all for free download. There is a section on children's fiction, Russian classics and even inspirational books, which his team has uploaded after contacting publishers around the world for permission, then scanning page by page. 'We always have one volunteer scanning books. My motto is "A million books for a billion people". No one should be denied reading material,' he says, indicating a corner of the office where a student is assiduously turning pages into PDFs.

Arvind wanders barefoot around the 400-sq. ft room in IUCAA that he shares with three other scientists, the volunteer or intern of the moment, and piles of egg cartons, books, straws, magnets, rubber bands, flip-flops, floppy discs, CDs, and assorted rejectamenta. 'This is modern-day junk that we use. People give it to us and feel good about reusing and recycling and all that, but they do not consume less,' he says. Finished toys litter the shelves; half-finished ones wait for their creators to return; homemade pinwheels

spin in the breeze; birds, houses and too-large insects fashioned from magazine covers are glued to monitors, and happy-looking skeletons cut out from paper flap on the walls of this toy factory like no other.

Twice a week, students from local schools come to the centre to watch the staff fashion toys from junk, play and make whatever they want. 'Children learn concepts from textbooks without understanding how they work practically. We try to bridge that gap by letting them have fun with science. In India, the commonality between a PhD and a primary school student is that neither ever gets hands dirty with practical science,' he says, setting a CD glued to a marble spinning on the cluttered table. 'See, a top. Once you make your own, you'll never forget that a good top has low moment of inertia and produces kinetic energy. Most simple toys are based on principles of physics. For hardly any money, a child has a toy and has learnt something,' he says.

This is the idea—simple and sensible science teaching—that drew Arvind away from the world of Tata trucks, a steady salary and corporate comfort at the age of twenty-five when his family thought he was nicely settled into a good job.

'I grew up in Bareilly in Uttar Pradesh, where my father was a failure of a businessman,' says Arvind, who was born in 1953. The family was always in debt but his mother was determined to send his two brothers, sister and him to school and so sold her jewellery to pay their fees. Arvind worked hard and ended up topping his district in the government intermediate examinations. He got a merit-cum-means scholarship to IIT Kanpur to study electrical engineering.

For a poor boy from a small town, IIT Kanpur offered all sorts of opportunities and exposure. 'IIT was heaven.

The library was fantastic, there was a film club, passionate teachers, an elite peer group, swanky infrastructure . . . I went crazy there. We saw the world's best cinema and listened to the country's best musicians. There was so much to tune your sensibilities,' he says.

Back then, IIT laid a lot of emphasis on social sciences so he took classes in philosophy, English, political science and economics along with his core subjects. The library was open from 8 a.m. to midnight every day and students could borrow ten books at a time. Arvind read everything he could lay his hands on.

The institute also had an aeromodelling and auto club but most of the students only flew the model planes and discarded them if they ran into trouble. He and his friend Akhilesh Agarwal fixed the broken engines and models and sold them back to the rich kids. 'I realized then that I'm a tinkerer at heart,' he says.

The 1970s were the years of student protests in Paris, the civil rights movement and anti-war protests in the US, the emergence of the environmental movement worldwide, and of Naxalism in India. World events trickled into the Kanpur campus and students spent hours discussing them. 'I found it a waste of time just to talk,' says Arvind. Instead of spending abstract hours discussing 'class conflict' and 'state hegemony', he and his friend Ashok Jhunjhunwala—now a professor at IIT Madras who works on taking technology to rural areas—decided to help the mess workers' children get an education. 'Here was a true example of class conflict. We studied in an elite institution yet the children of the workers who served us the chai over which we had these debates did not even have a school,' he says.

So they joined a group on campus, Sahyog, and went from door to door collecting money to begin classes. It was

Arvind's first experience of teaching. 'The class had about thirty students and I realized how eager children are to learn, how quick they are to pick up,' he says. He spent three years juggling college and teaching and saw the first batch finish their high school exams.

While he's chatting, his hands are busy. He saws through an old CD, sticks the triangle into the base of a discarded flip-flop, makes two deep incisions and inserts four ring magnets. He slips a couple more ring magnets on to a pencil and sets the pencil spinning, its nib against the cannibalized CD. It stays suspended in mid-air, held in space by the opposing forces of the sets of magnets. 'Magic?' He chuckles. 'This is the principle on which the Maglev [magnetic levitation] train runs. If a child assembles this for himself, he'll never forget and never want to give up science. It doesn't cost much for a school to buy a whole lot of ring magnets. The rest is all junk. Schools are mass factories that churn out idiots. Make learning related to life and it becomes more interesting,' he says.

One of the many speakers who came to IIT Kanpur in 1972 was Dr Anil Sadgopal, who was running the Hoshangabad Science Teaching Programme in sixteen government schools in Madhya Pradesh. Sadgopal wanted to improve science teaching using activities that could be put together with low-cost, locally available materials so that children in villages no longer needed to merely memorize definitions and formulae. The idea of simplifying science and the image of children busily doing experiments and loving them enchanted Arvind.

After college, he got a job at Telco—now Tata Motors—and moved to Pune for training in 1975. 'The campus was beautiful and the people friendly. I was in the maintenance division and enjoyed my work,' he says. About a year in, he

began to feel that it wasn't for him, that something wasn't right. 'At that time we didn't have such words for it, but I was what is now described as "socially aware". My work did not fulfil that part of my mind. I just knew I was not born to make trucks,' he says. 'I didn't know what I wanted to do but it was enough to know what I did not want to do.'

Most of his peers—colleagues as well as former classmates—seemed perfectly content to have studied in the best institutes in the country and landed jobs in the best companies of the time. 'It wasn't enough for me, but I couldn't understand why,' he says. To work through the turmoil in his mind, he thought back to the days in IIT when he had felt happiest and most inspired. 'I remembered Dr Sadgopal's talk. Using so little to do so much, that was inspiring,' he says. Arvind wrote him a postcard asking if he could visit. 'That fifteen-day trip opened my eyes. I loved his stories of struggle and science.'

Back at work, he told his employers he wanted to join the science project and they gave him a year off. 'The 1970s were a time when everyone believed in going to the villages and starting there to bring about change,' he says.

In 1978, Arvind set off for Pallia Piparia village in Madhya Pradesh with his uncles' dire warnings of poverty and his mother's encouragement. 'My mother said, "Good, now you will do something useful with your life." My uncles said, "It is a mistake. Village life is not for you." I focused on the positive things my mother said and ignored the rest. It's the approach he has taken most of his life—looking at the positives to overcome the negative.'

In the first week, he went to the local market to see what he could find to work with, and bought one specimen of everything being sold on the roadside. Among the paraphernalia was a foot of bicycle valve tubing that

cost 10p and a matchbox for 15p with which he started experimenting.

He cut the matchsticks and tube, balanced them, weighed them, filled them with water and sand, measured them, played around and pondered. He discovered that the drawer of the matchbox holds 20 ml of water—a handy bit of knowledge for village schools that cannot afford to buy glass measuring tubes. One day, while he was fiddling with the matchboxes and cycle tubing, a matchstick slipped snugly into a length of the black cycle tube. He picks up tubing and slides a matchstick in to demonstrate. 'Another matchstick went on the other end. I had made a flexible joint of two.' He wiggles the two matches to show how supple the joint is.

It was the beginning of the work that would make him famous as the master of Matchstick Mecanno and win him the Central Government's inaugural National Award for Science Popularization amongst Children in 1988. 'With these simple joints, you can demonstrate the properties of the acute angle, obtuse angle, right angle... Another bit of tube on the other end of the match and you can connect them to make a triangle,' he says.

Arvind speeds up, picking up a range of shapes he has already made and rattling off the properties of rectangles, rhombuses, squares, parallelograms, all the while pulling and pushing the jointed matchsticks to make different shapes. Suddenly, it's back to the triangle. 'See if you can push the triangle into some other shape. No? A triangle is solid, rigid. This is the basis of all civil and mechanical engineering: If you want stability divide a space into triangles; but so few engineering students appreciate this simple concept because they've never seen it practically.' He seems to be in showman mode as if he's giving a TED talk

or holding a workshop, almost listening for the applause that his practical magic always draws. He demonstrates the making of a three- and a four-way joint and shows three-dimensional shapes. Despite the fact that you know what comes next, having seen the videos at least ten times on YouTube, you find yourself exclaiming with glee at the simplicity, the ingenuity, the sheer fun and his own enthusiasm for his matchless shapes. 'So simple, so simple. I love it. I'm hooked to these shapes and their science,' he says.

During his year off from Tata, he took the train to Trivandrum and spent four months working with his other college-day hero, architect Laurie Baker, who used local designs and materials to build houses for the poor. 'He was an amazing man, so full of fun and laughter yet doing serious work that touched others.'

Arvind went back to Tata early in 1980 after his year was up but couldn't settle in. He enjoyed the work since it involved tinkering with trucks but it didn't make him happy. Questions like 'Who does my work really benefit?' and 'Why do the people who work the hardest get paid the least?' kept eating at him.

When his mother fell ill, he quit and moved home to Bareilly to nurse her till her death at the end of 1980. 'It is one of the good things I have done in my life,' he says. 'She is the one who gave me very high self-esteem and self-worth, and the belief that you can't eat rupees and dollars because it is meaningful work that sustains you.'

From 1981 to 1983, he was part of an iron ore miners' trade union in Chhattisgarh, teaching the workers' children and editing the union's newspaper. 'I was full of idealism. I loved those days. I learnt how the other half lived and died. It lent meaning to words such as integrity, labour and

equality that we'd grown up talking about but not really practising,' he says.

Around this time, his sister and brother-in-law placed matrimonial ads in newspapers for him. 'Sunita, now my wife, responded. She is wonderful, and came out to the mines for a year,' he says. 'I don't know anyone else who would have so willingly accepted someone like me, someone who wasn't ready to do what everyone else did.'

They returned to Pune in 1984, just before the birth of their daughter Dulari. 'We had no money, so we came back,' Arvind says. He applied for and got a grant from the Department of Science and Technology to write a book on his matchstick models, *Khel-Khel Mein*, which he later translated into English as *Matchstick Models and Other Science Experiments*. It has since gone into thirteen Indian languages and sold over half a million copies. Since then, he's written twenty books on simple science, and translated more than 160 into Hindi.

In the late 1980s, the family moved to New Delhi as Sunita wanted to do a PhD at Jawaharlal Nehru University. Arvind ran the science club at Mirambika Free Progress School, where his daughter studied, and conducted workshops. He started creating experiments for NCERT textbooks and joined the National Book Trust's advisory panel, and has continued with both for the past twenty years. He also did a series of programmes for Doordarshan, teaching children to make toys from trash. 'Children want to make things, do things, not just study the textbook,' he says. He conducted workshops in more than 2000 schools in India, and at seminars and conventions around the world.

Once Dulari went to medical college in Vellore, Arvind and Sunita decided to move back home to Pune in 2003.

Sunita got a job teaching sociology at Fergusson College. 'I'd always freelanced yet managed to do things I liked. I wasn't worried about starting over,' he says. 'For fourteen years, I cooked lunch and kept house for my wife and daughter. I did science workshops in all 300 schools in Delhi but I'd be home by 2 p.m. to give them food. Having the time to watch my daughter grow up and provide support while my wife studied and worked has been one of the good things of this career.'

Though Arvind hasn't been part of the mainstream, his IIT old-boy network has helped him. He often strays into stories of an old friend or a friend of a friend who helped out—friends who turn out to be captains of industry, respected educationists and activists, highly placed bureaucrats, or their friends and relatives. It is clear that the goodwill and respect he has is entirely due to the kind of work he does and the energy he brings to it. 'I have a very undemanding family and a groundswell of good feeling that keeps me going. My "wife insurance" is good, plus I am an eternal optimist,' he says, chuckling.

In October 2003, when IUCAA called him with a plan for a science centre funded by Tata Trust, he signed on happily. 'The four of us here work at a tenth of our market salaries because we believe we must do something worthwhile every minute of our lives,' he says.

Since 2009, when a friend taught the team how to use a video camera, record audio and edit films, they have been filming their experiments and uploading them on YouTube. The videos are no-nonsense affairs—a red cloth on a table serves as the set against which a pair of hands demonstrates the experiment while a clear voice-over explains the concept. The 4600 films have gone into eighteen languages and more than 50,000 children view them every day.

The videos and documents are free for anyone to translate as long as his team is credited.

Someone in Poland dubbed one of his films into Polish in August 2012. 'It was viewed five lakh times in a month. They wrote us a letter saying they had never seen anything like it. Neither had we, so we used Google translator to understand the letter,' he says, chuckling at one of his rare jokes.

Arvind retired from IUCAA at the end of December 2014, after he turned sixty-one, and now splits his time between Pune, where Sunita still has three years to go before retirement, and Vellore, where Dulari works as a paediatrician. 'In January 2012, I was diagnosed with prostate cancer and went through forty-two rounds of radiotherapy. I am fine and stable but I think it's time to focus on my other passion,' he says.

That 'other passion' is translating books into Hindi. 'When I was growing up, I always felt there was never enough to read in Hindi, the language I was most comfortable in. Maybe that's why I have 10,000 books now. Childhood deprivation leads you to swing to the other extreme,' he says. 'Until people read good books, how will they write them?' Arvind will continue to spread the good word by translating books into Hindi to add to the 170 digitized versions on his website. 'Everyone should have access to books,' he says. 'There is deep joy in sharing.'

ARVIND'S PLAY WAY

1. Play is serious business. Children—and adults—who play are happier people. Make your work your play.
2. Do something worthwhile with your life. Always ask questions of your life—if you are happy, if you are doing something meaningful, if this is what you were made for.
3. We have only one life and we must live our own dream, never a stale corporate dream.